TURBOFAN ENGINE ASSEMBLY AND METHOD OF ASSEMBLING SAME

BACKGROUND OF THE INVENTION

[0001] This invention relates generally to gas turbine engines, and more specifically to a turbofan engine assembly that includes a counter-rotating booster compressor.

[0002] At least some known turbofan engine assemblies include a fan assembly, a core gas turbine engine, and a low-pressure or power turbine. The core gas turbine engine includes at least one compressor, a combustor, and a high-pressure turbine that are coupled together in a serial flow relationship. Moreover, at least one known turbofan engine assembly includes a booster that is disposed between the fan assembly and the core gas turbine engine.

[0003] To improve the efficiency of the turbofan engine assembly, it is desirable to operate the fan assembly at a relatively low speed to improve fan efficiency and to operate the high-pressure turbine at a relatively high speed to improve the high-pressure turbine efficiency. However, operating the fan assembly at a relatively slow speed may be detrimental to the operation of a booster. As such, additional stages may be required on the booster to facilitate operating the booster at maximum efficiency, thus increasing the overall cost and design complexity of the turbofan engine.

BRIEF DESCRIPTION OF THE INVENTION

[0004] In one aspect, a method of assembling a turbofan engine is provided. The method includes providing a core gas turbine engine including a high-pressure compressor, a combustor, and a turbine, coupling a counter-rotating booster compressor to the core gas turbine engine, the counter-rotating booster compressor including a first rotor section configured to rotate in a first direction and a second rotor section configured to rotate in an opposite second direction, coupling a gearbox to at least one of the first and second rotor sections, and coupling a low-pressure turbine to the gearbox such that the gearbox is driven by the low-pressure turbine.

[0005] In another aspect, a turbofan engine assembly is provided. The turbine engine assembly includes a core gas turbine engine including a high-pressure compressor, a combustor, and a turbine. The turbofan engine assembly also includes a low-pressure turbine coupled to the core gas turbine engine, a counter-rotating booster compressor including a first rotor section configured to rotate in a first direction and a second rotor section configured to rotate in an opposite second direction, and a gearbox including an input and an output, the gearbox output coupled to at least one of the first and second rotor sections, the gearbox input coupled to the low-pressure turbine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. **1** is a cross-sectional view of a portion of an exemplary turbofan engine assembly that includes a gear driven booster;

[0007] FIG. **2** is an enlarged cross-sectional exemplary booster arrangement that may be utilized with the turbofan engine assembly shown in FIG. **1**;

[0008] FIG. **3** is a cross-sectional view of a portion of the gearbox shown in FIG. **2**;

[0009] FIG. **4** is an end view of the gearbox shown in FIG. **2**;

[0010] FIG. **5** is an enlarged cross-sectional view of an exemplary booster arrangement that may be utilized with the turbofan engine assembly shown in FIG. **1**;

[0011] FIG. **6** is an enlarged cross-sectional view of an exemplary booster arrangement that may be utilized with the turbofan engine assembly shown in FIG. **1**;

[0012] FIG. **7** is an enlarged cross-sectional view of an exemplary booster arrangement that may be utilized with the turbofan engine assembly shown in FIG. **1**;

[0013] FIG. **8** is an enlarged cross-sectional view of an exemplary booster arrangement that may be utilized with the turbofan engine assembly shown in FIG. **1**;

[0014] FIG. **9** is a simplified schematic illustration of an exemplary booster arrangement that may be utilized with the turbofan engine assembly shown in FIG. **1**;

[0015] FIG. **10** is a simplified schematic illustration of an exemplary booster arrangement that may be utilized with the turbofan engine assembly shown in FIG. **1**; and

[0016] FIG. **11** is a simplified schematic illustration of an exemplary booster arrangement that may be utilized with the turbofan engine assembly shown in FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

[0017] FIG. **1** is a schematic illustration of an exemplary turbofan engine assembly **10** having a longitudinal axis **11**. Turbofan engine assembly **10** includes a fan assembly **12**, a core gas turbine engine **13** that is disposed downstream from fan assembly **12**, and a low-pressure turbine **20** that is disposed downstream from the core gas turbine engine. The core gas turbine engine includes a high-pressure compressor **14**, a combustor **16**, and a high-pressure turbine **18**. In the exemplary embodiment, turbofan engine assembly **10** also includes a multi-stage booster compressor **22**.

[0018] Fan assembly **12** includes an array of fan blades **24** extending radially outward from a rotor disk **26**. Turbofan engine assembly **10** has an intake side **28** and an exhaust side **30**. Compressor **14** and high-pressure turbine **18** are coupled together by a second drive shaft **32**.

[0019] FIG. **2** is an enlarged cross-sectional view of a first booster compressor arrangement that may be utilized with turbofan engine assembly **10** shown in FIG. **1**. As shown in FIG. **2**, booster **22** is a counter-rotating booster compressor **22** that includes a first rotor section or spool **50** that, in the exemplary embodiment, includes two stages **52** each including a respective disk **54** and a plurality of blades **56** coupled to each respective disk **54**. Counter-rotating booster compressor **22** also includes a second rotor section or spool **60** that, in the exemplary embodiment, includes three stages **62** each including a respective disk **64** and a plurality of blades **66** coupled to each respective disk **64**. In the exemplary embodiment, a first stage **70** of second rotor section **60** functions as rotating inlet guide vanes (IGV) to facilitate channeling airflow entering turbofan engine assembly **10** downstream through booster **22**, and a plurality of stationary vanes **72** function as outlet guide vanes (OGVs). Although booster compressor **22** is shown as having only five stages, it should be realized that booster compressor **22** may have any quantity of stages of rotor blades.

[0020] In the exemplary embodiment, turbofan engine assembly also includes a gearbox **100** that includes a gearbox housing **101**. Gearbox **100** is a dual output gearbox that includes an input **110**, a first output **111**, and a second output **112** that is coupled to second rotor section **60**. In this